Cosmo stuff

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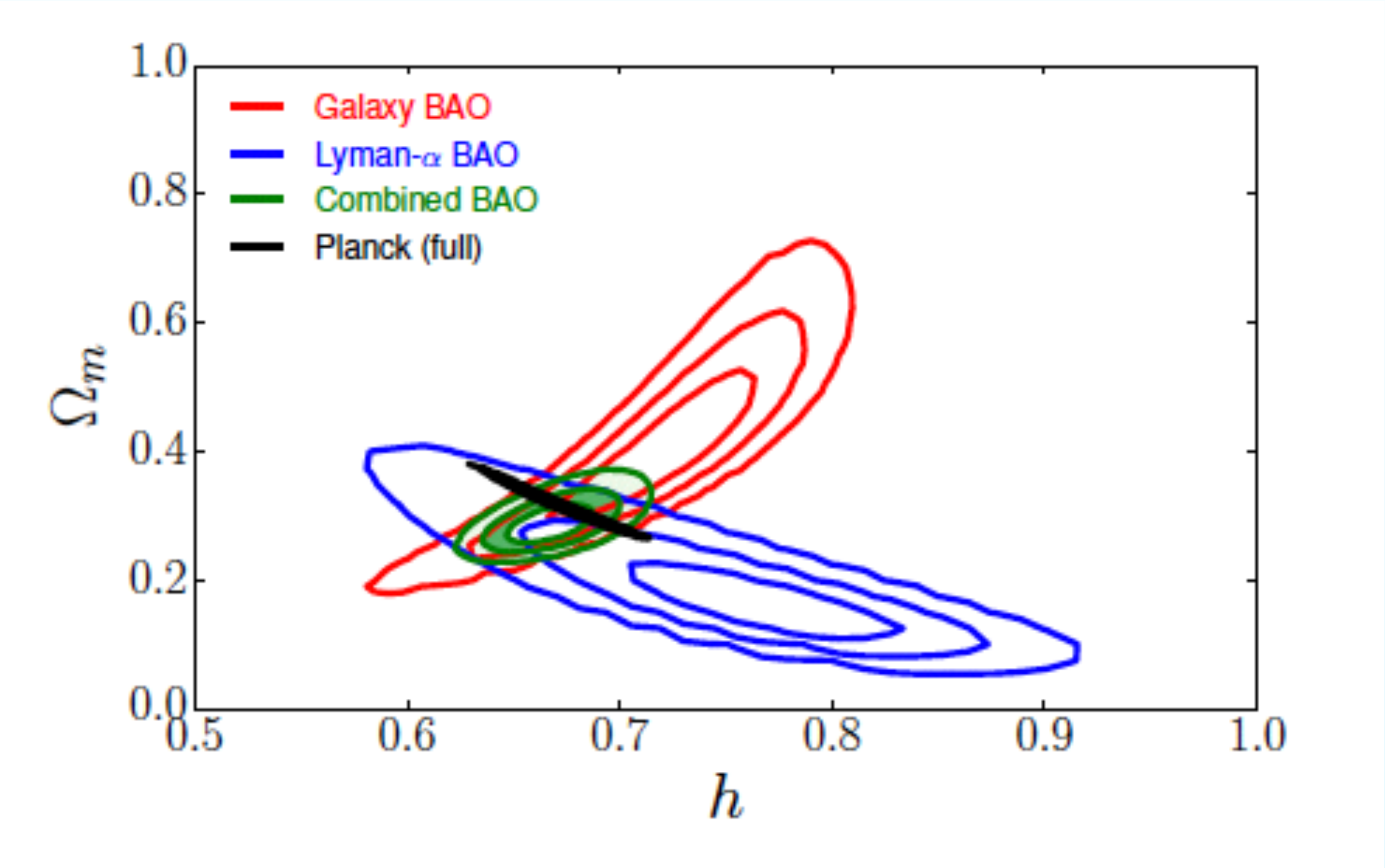
- Gaussian Embedding Sampling

- BOSS - DR12

- Early Dark Energy



SimpleMC

To compute parameter constraints we built a simple and fast MCMC code

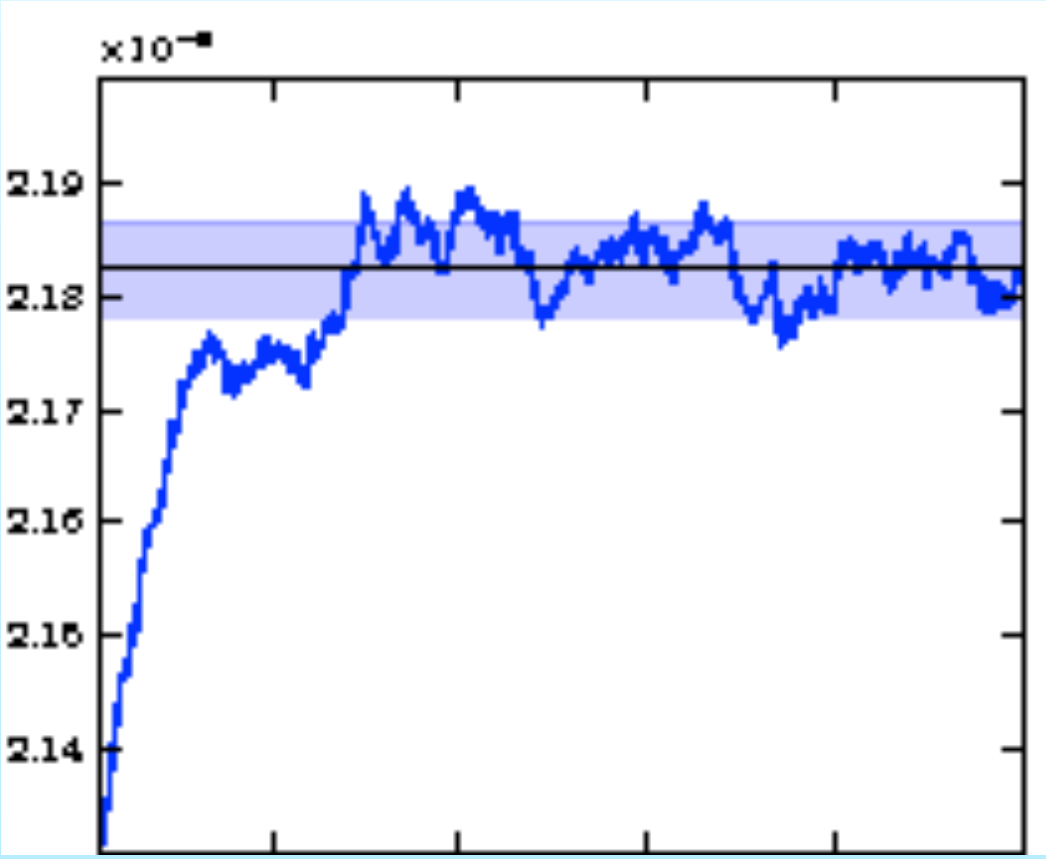
`https://github.com/slosar/april`

SimpleMC

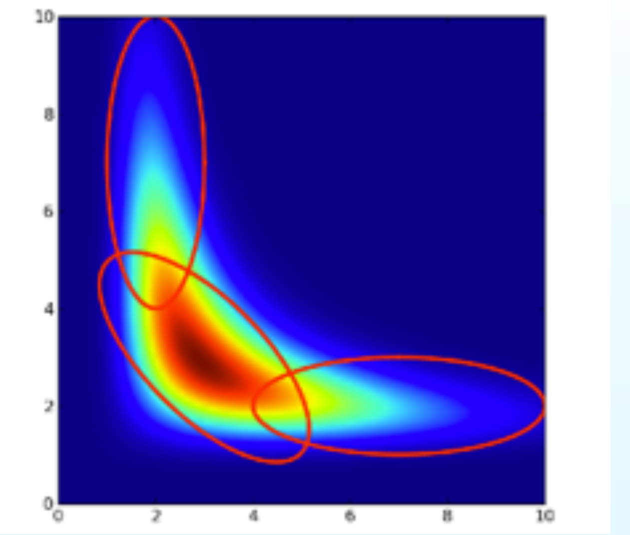
MCMC is an algorithm that walks around the likelihood and produces samples

- Scales perfectly for small number of chains, but not on modern architectures with 1000s of cores one always needs to throw away some ~thousands steps, because of the **burn in period**.

  (the initial state is “forgotten")



Gaussian Embedding Sampling



- Populate a lists of Gaussians with a single Gaussian centered at a chosen point with a suitable covariance

- Take N samples from the most recently added Gaussian

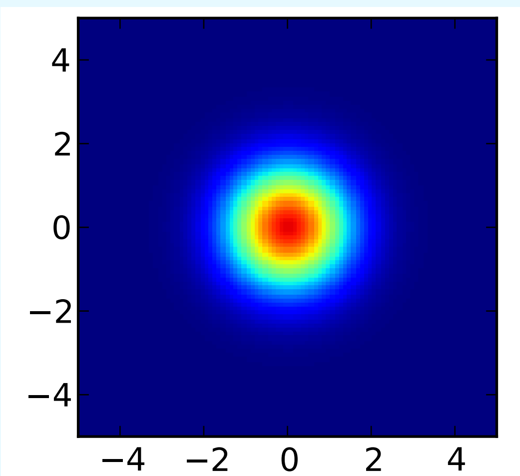
- Calculate importance sample weights $$w_i = A \frac{L_{\mathrm{t}}(\mathbf{x}_i)}{\sum_{j=1 \ldots M} G_j(\mathbf{x}_i - \mu_j, \mathbf{C}_j)}$$

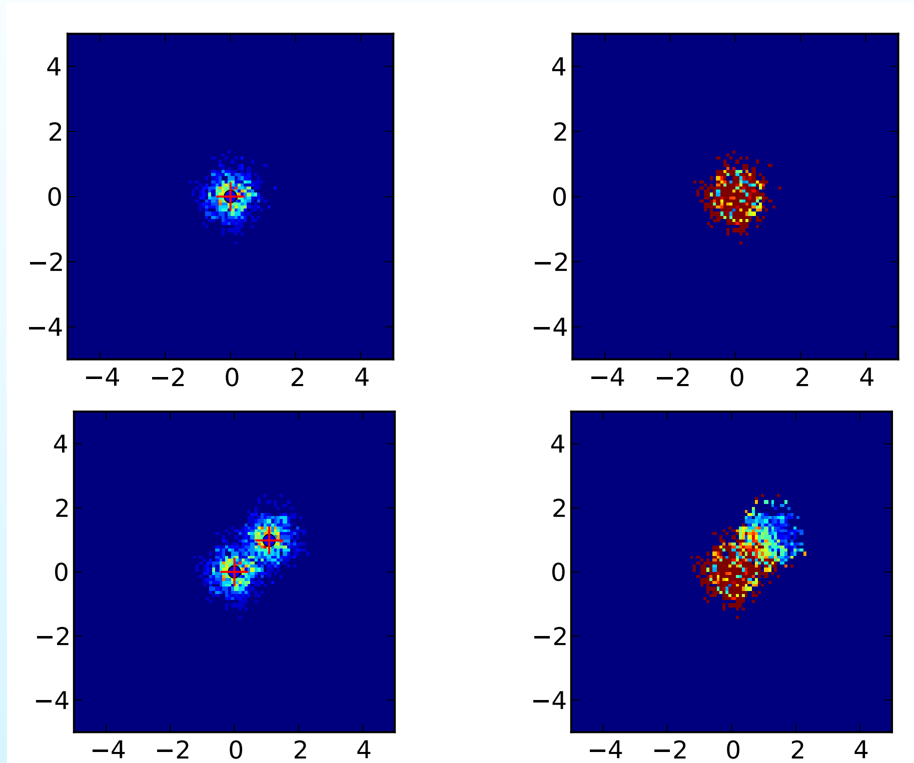
  If L_S is sampling the target distribution well the weights will be around unity, << 1 we are oversampling the parameters space and >> 1 where we are undersampling parameter space

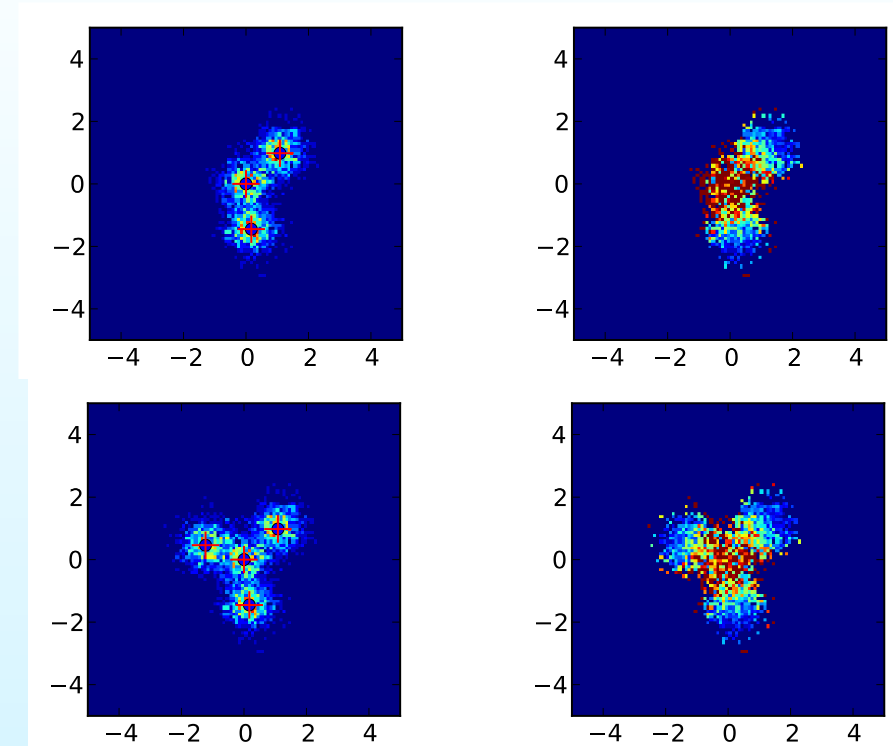
- Add a new Gaussian at the position of the largest importance weight

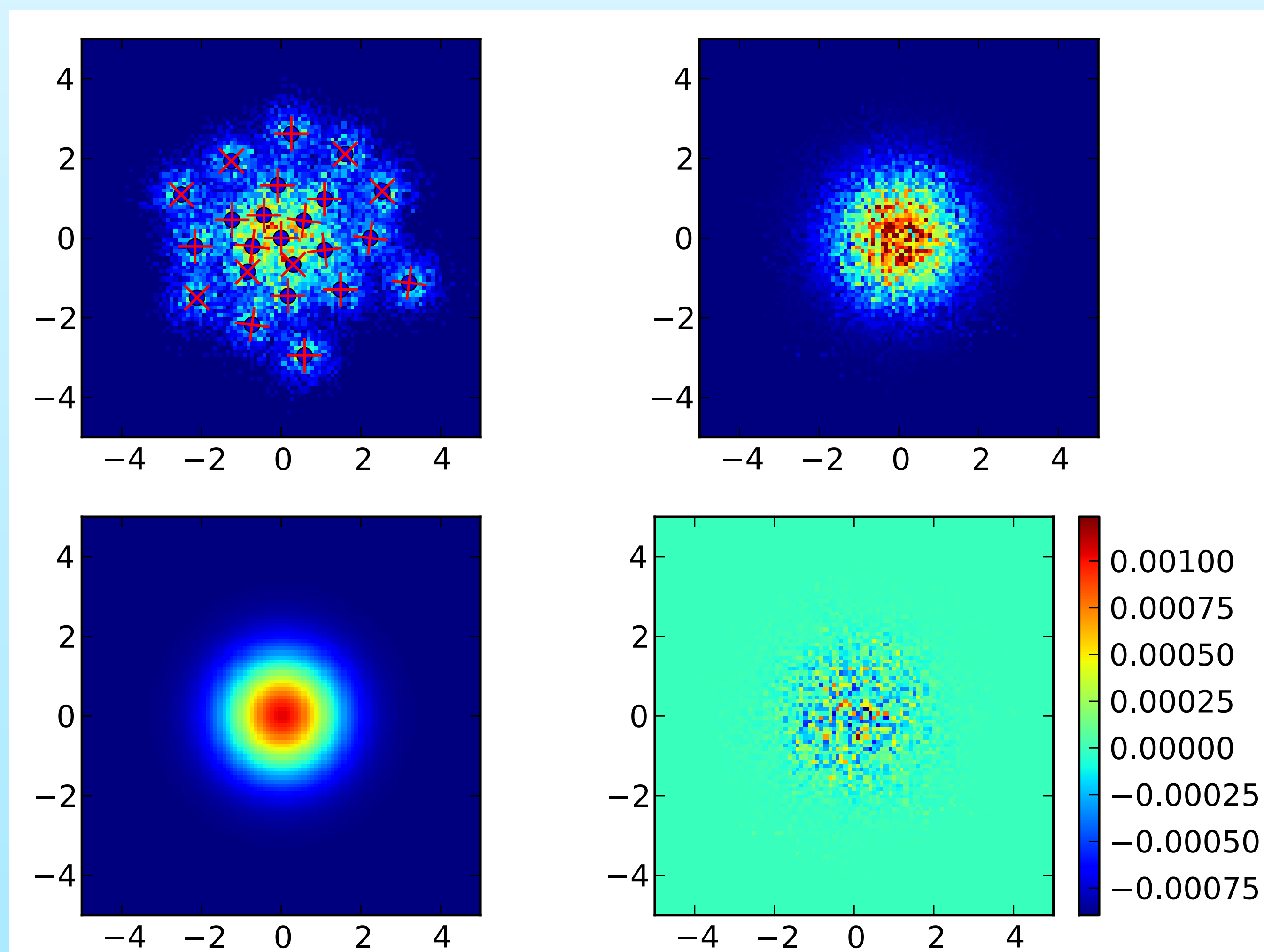
- Repeat step 2, until convergence

Gaussian

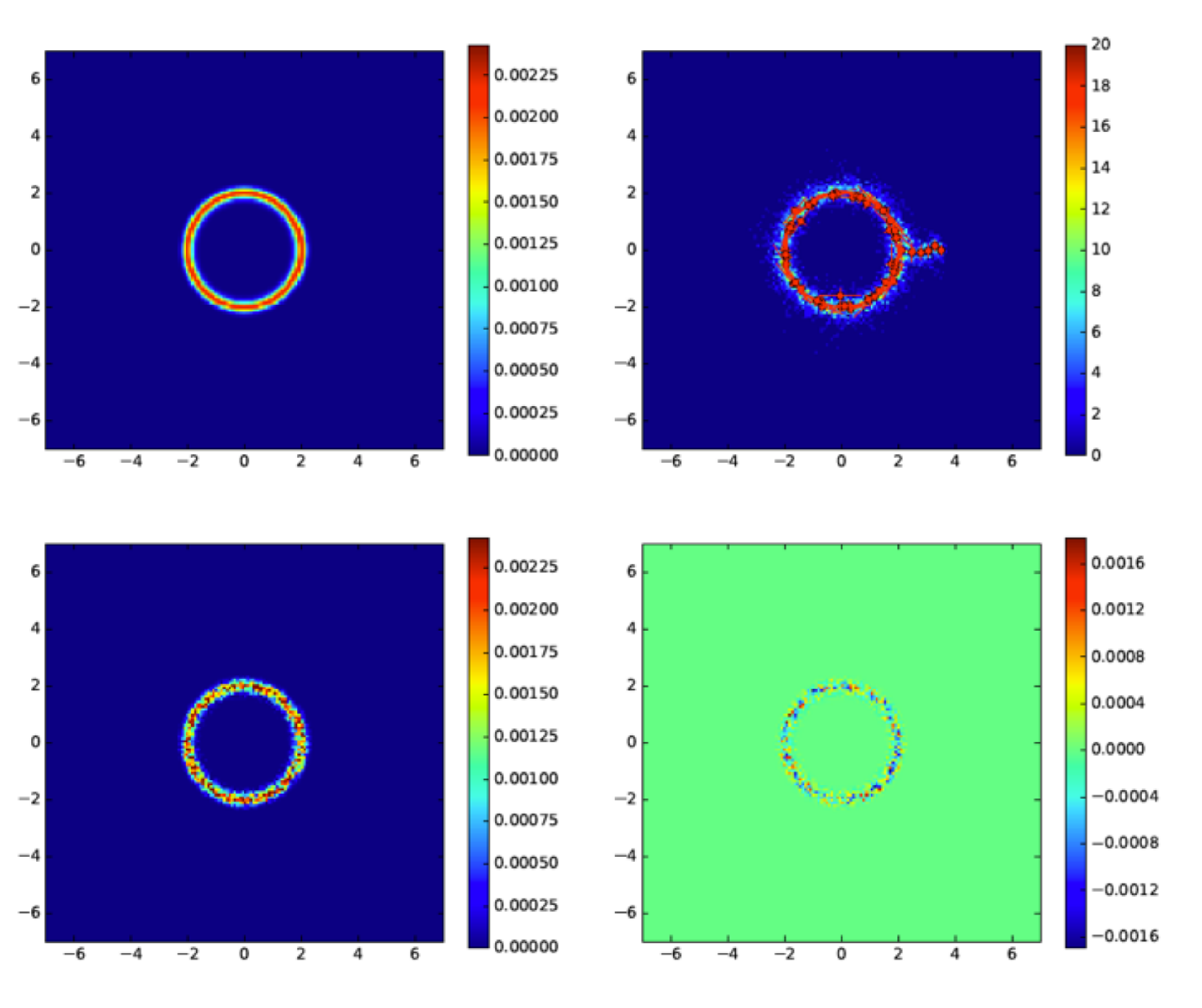






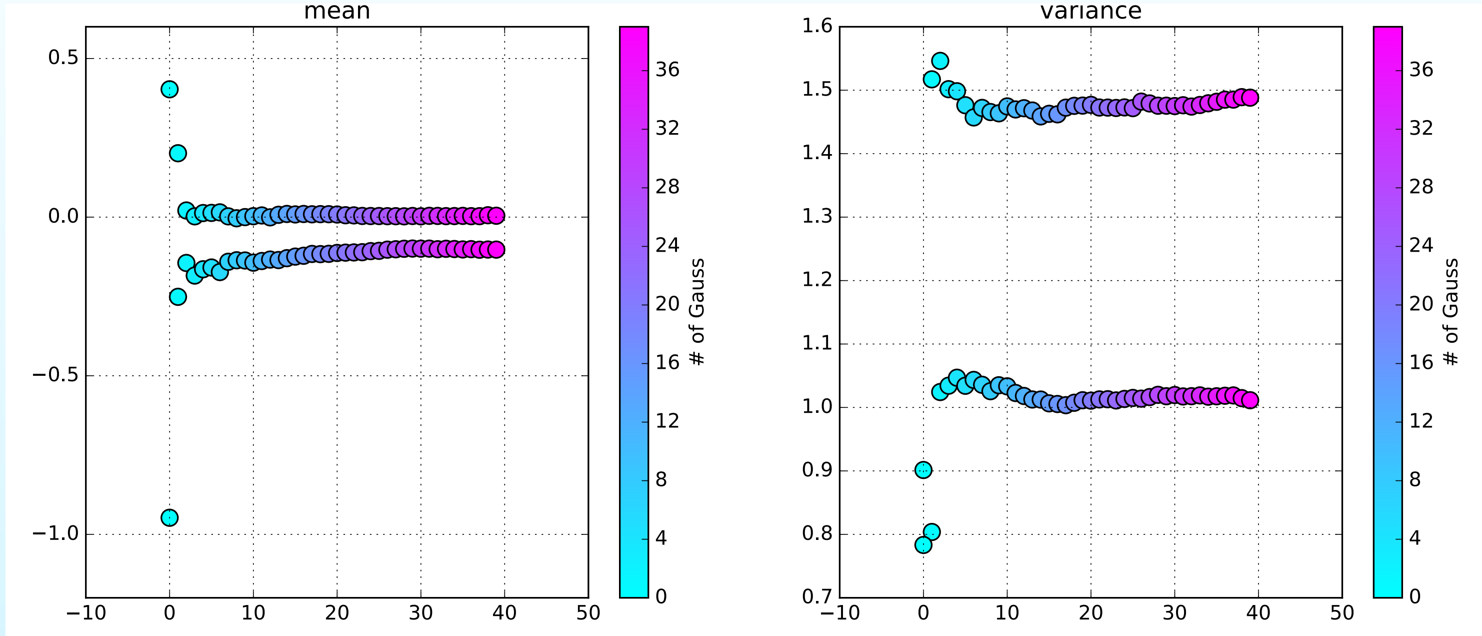


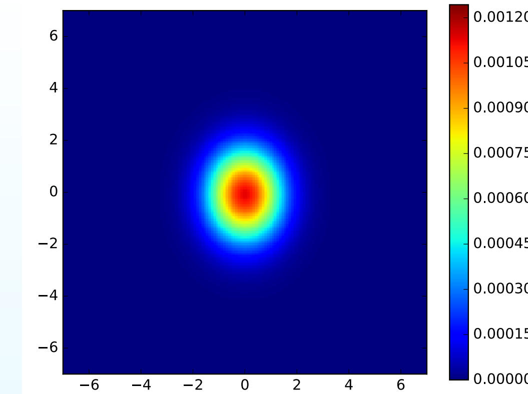
$$w_i = A \frac{L_{\mathrm{t}}(\mathbf{x}_i)}{\sum_{j=1\ldots M} G_j(\mathbf{x}_i - \mu_j, \mathbf{C}_j)}$$

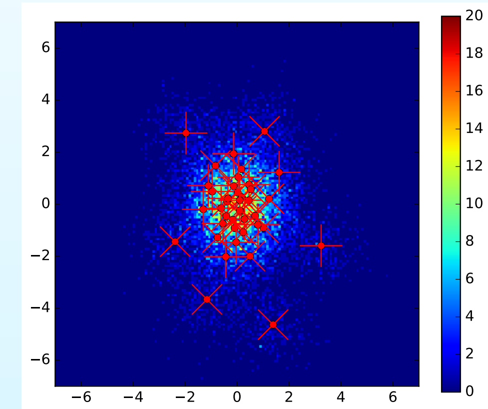


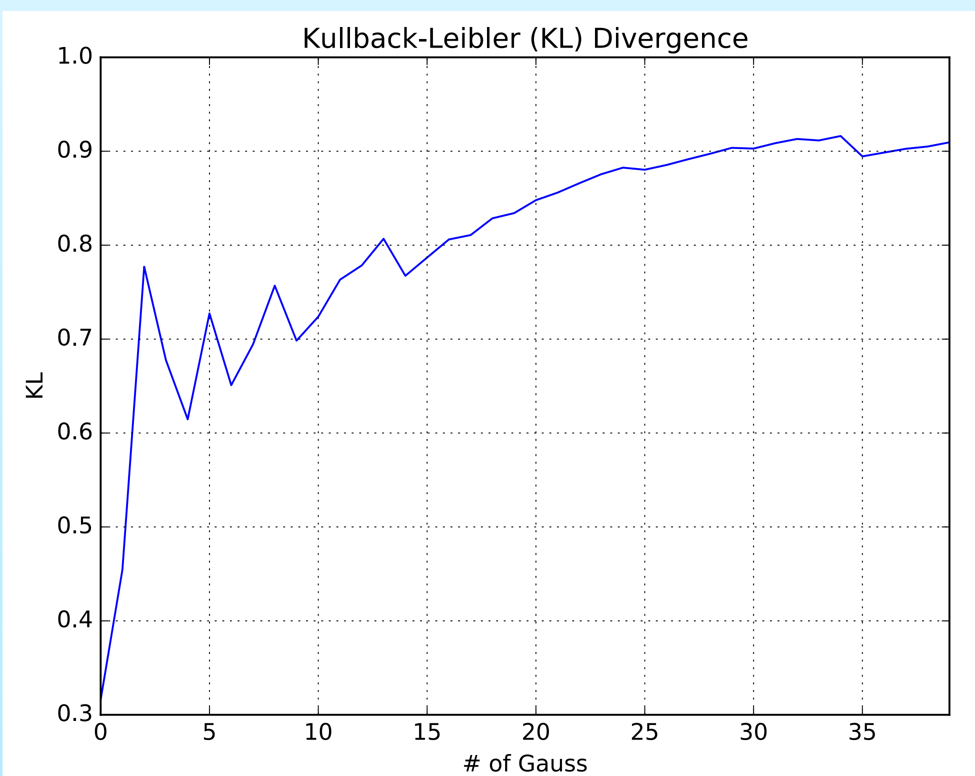
0.00225
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
20
18
16
14
12
10
8
6
4
2
0
0.0016
0.0012
0.0008
0.0004
0.0000
−0.0004
−0.0008
−0.0012
−0.0016

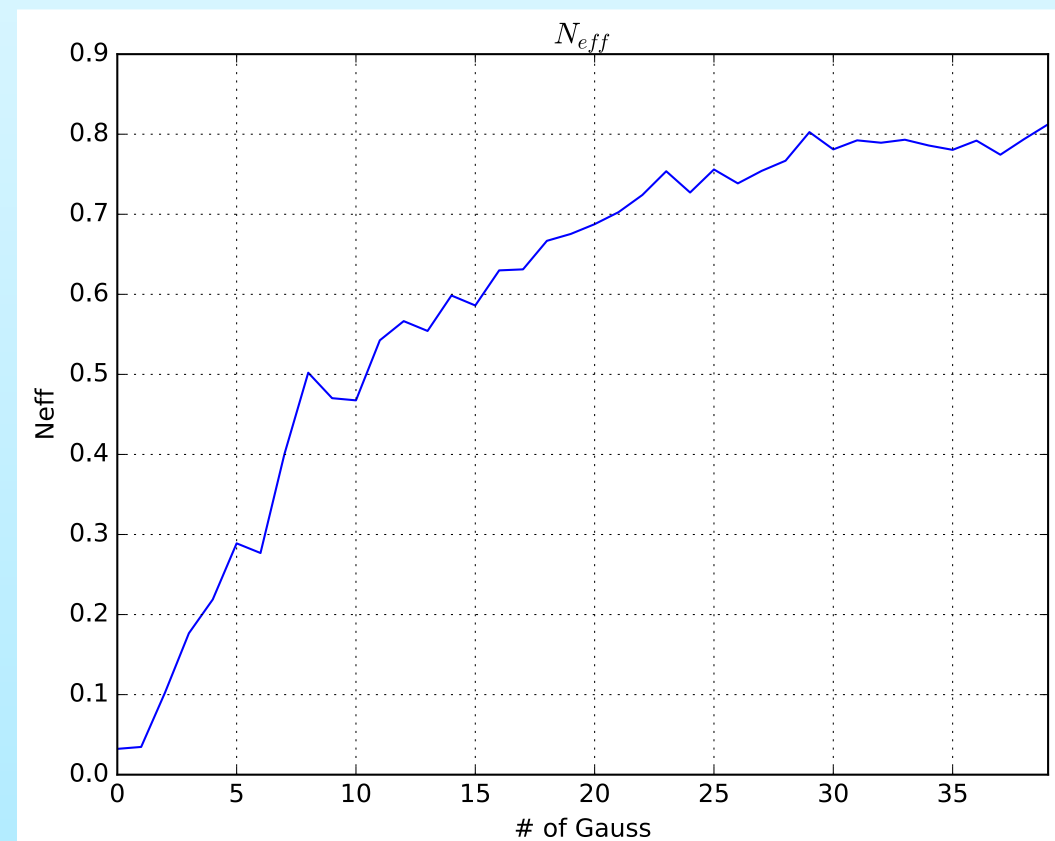
Stopping criteria









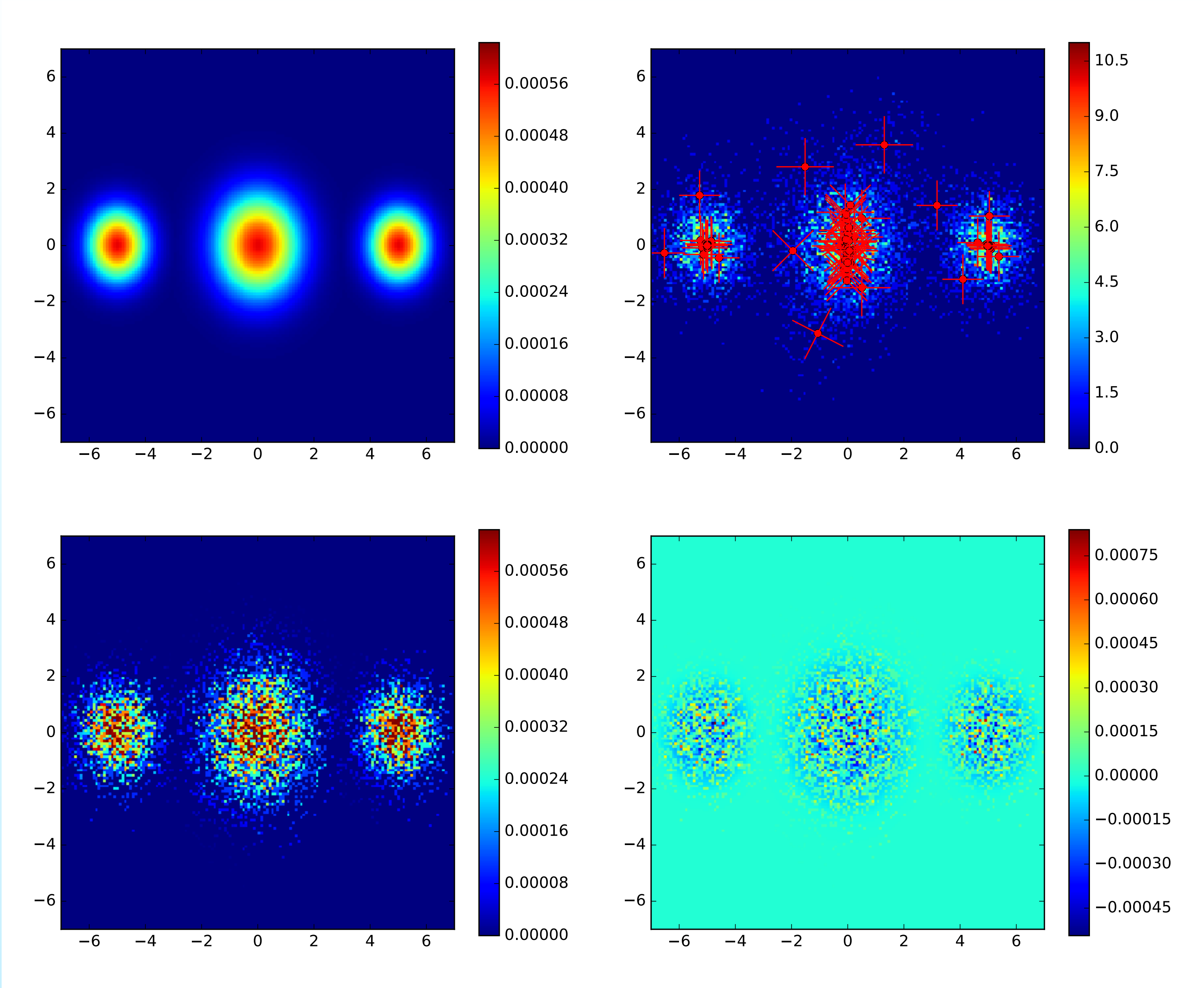


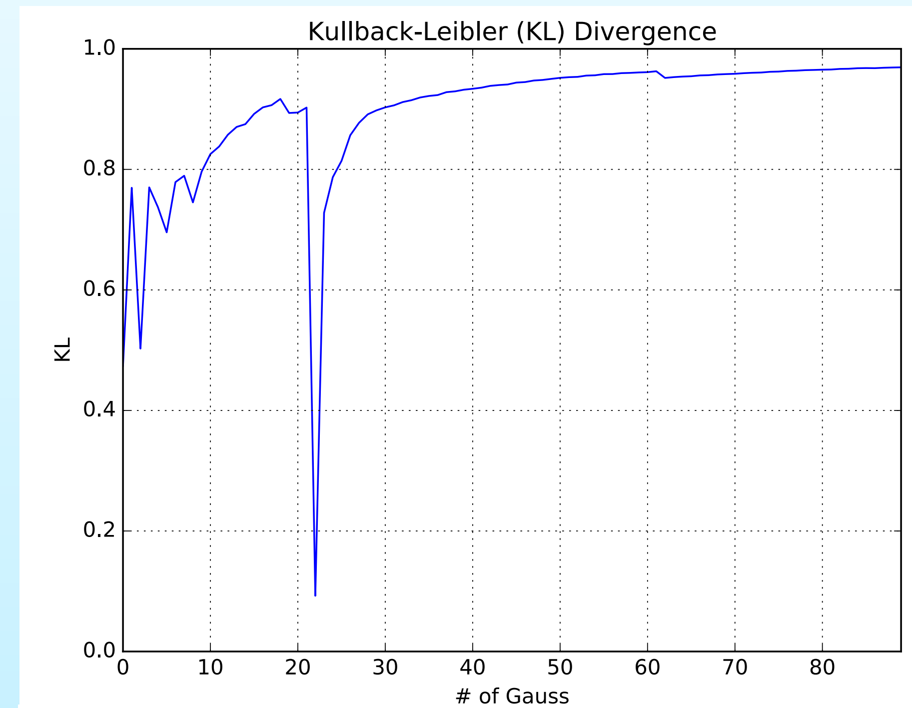
Values close to 1 indicate good agreement between the importance function and the target density.

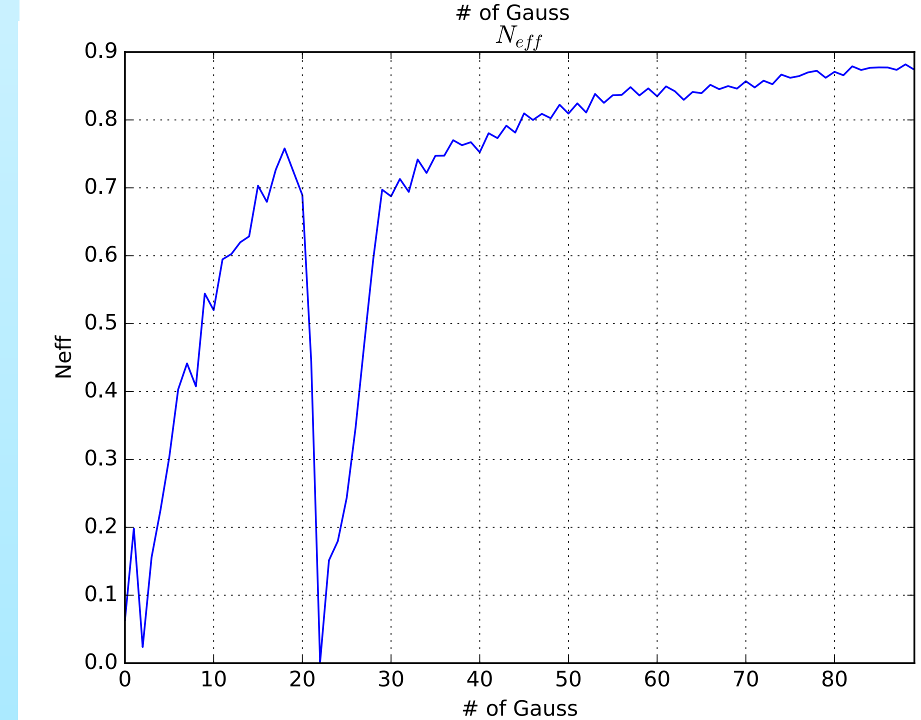
The effective number of samples

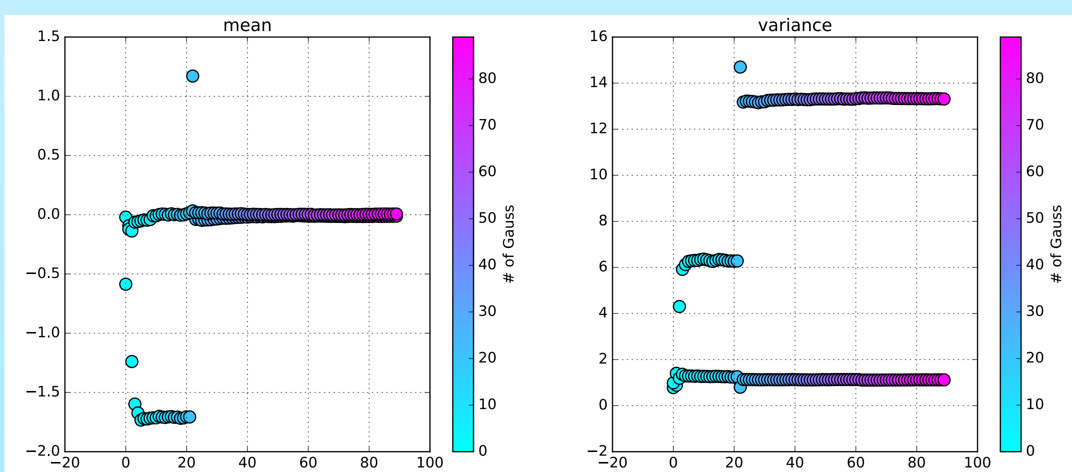
$$N_{\rm eff} = \frac{\sum w_i}{max(w_i)}$$

For fun ..

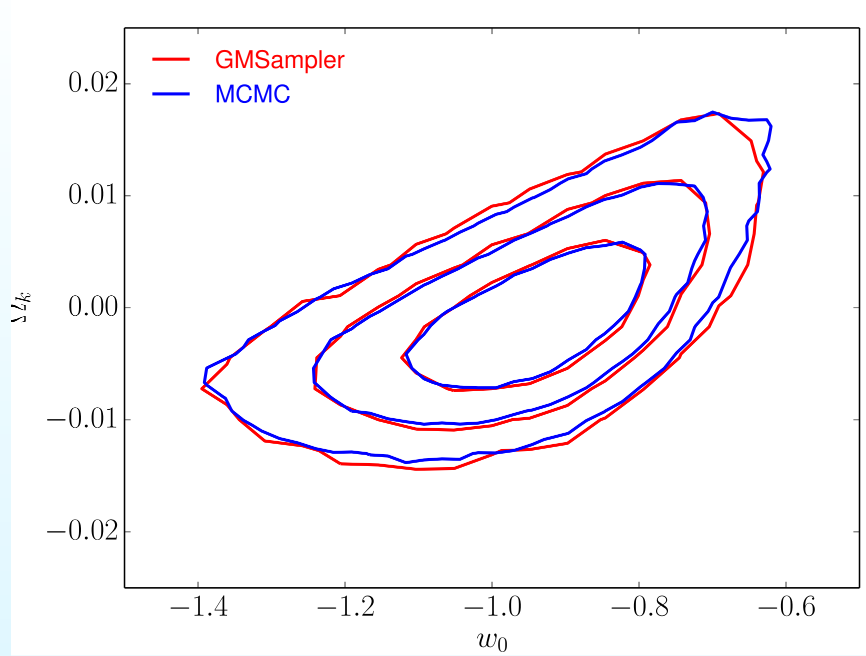



Kullback-Leibler (KL) Divergence
KL
# of Gauss


N_{eff}
Neff
# of Gauss


mean
# of Gauss
variance
# of Gauss

Use real data



Samplers

CosmoSIS comes with a range of samplers suitable for different likelihoods spaces.

Simple:

- test sampler Evaluate a single parameter set
- list sampler Re-run existing chain samples

Classic:

- metropolis sampler Classic Metropolis-Hastings sampling
- importance sampler Importance sampling
- fisher sampler Fisher Matrices

Max-Like:

- maxlike sampler Find the maximum likelihood using various methods in scipy
- gridmax sampler Naive grid maximum-posterior

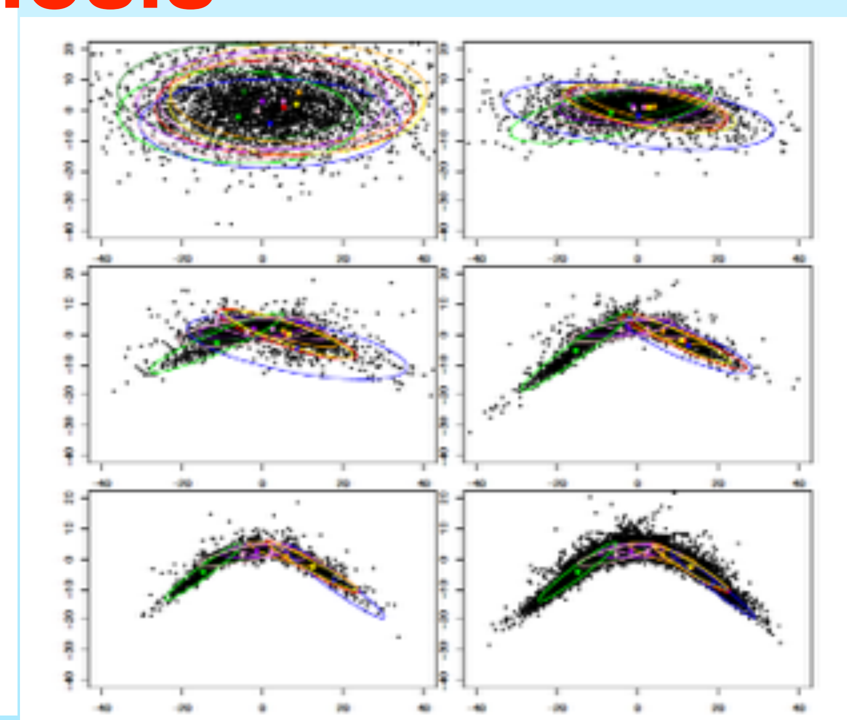
Ensemble:

- emcee sampler Ensemble walker sampling
- kombine sampler Clustered KDE
- multinest sampler Nested sampling
- pmc sampler Adaptive Importance Sampling

Grid:

- grid sampler Regular posterior grid
- snake sampler Intelligent Grid exploration

Cosmosis



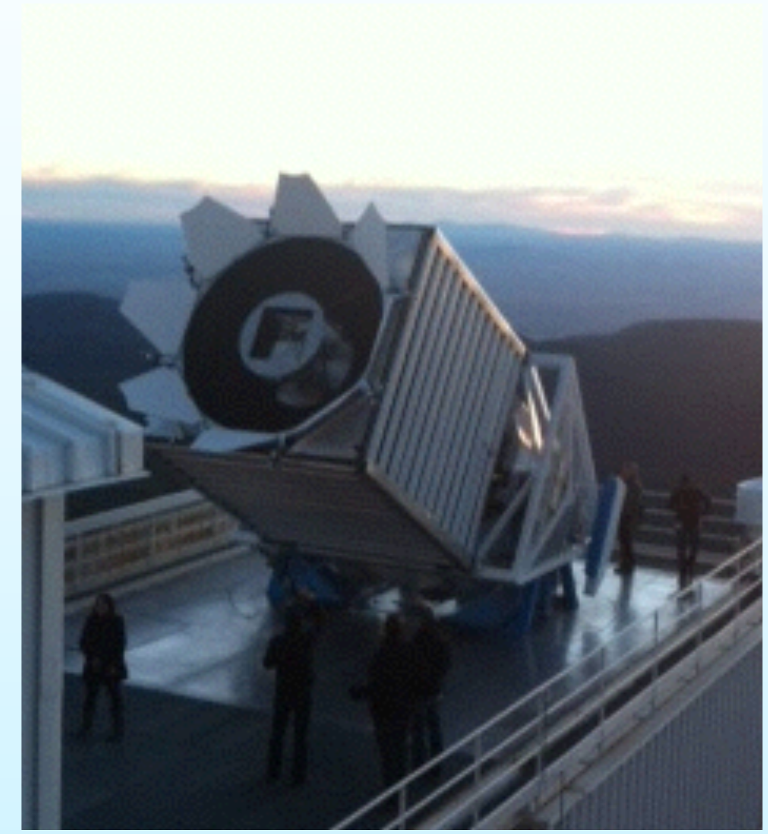
BOSS - DR12

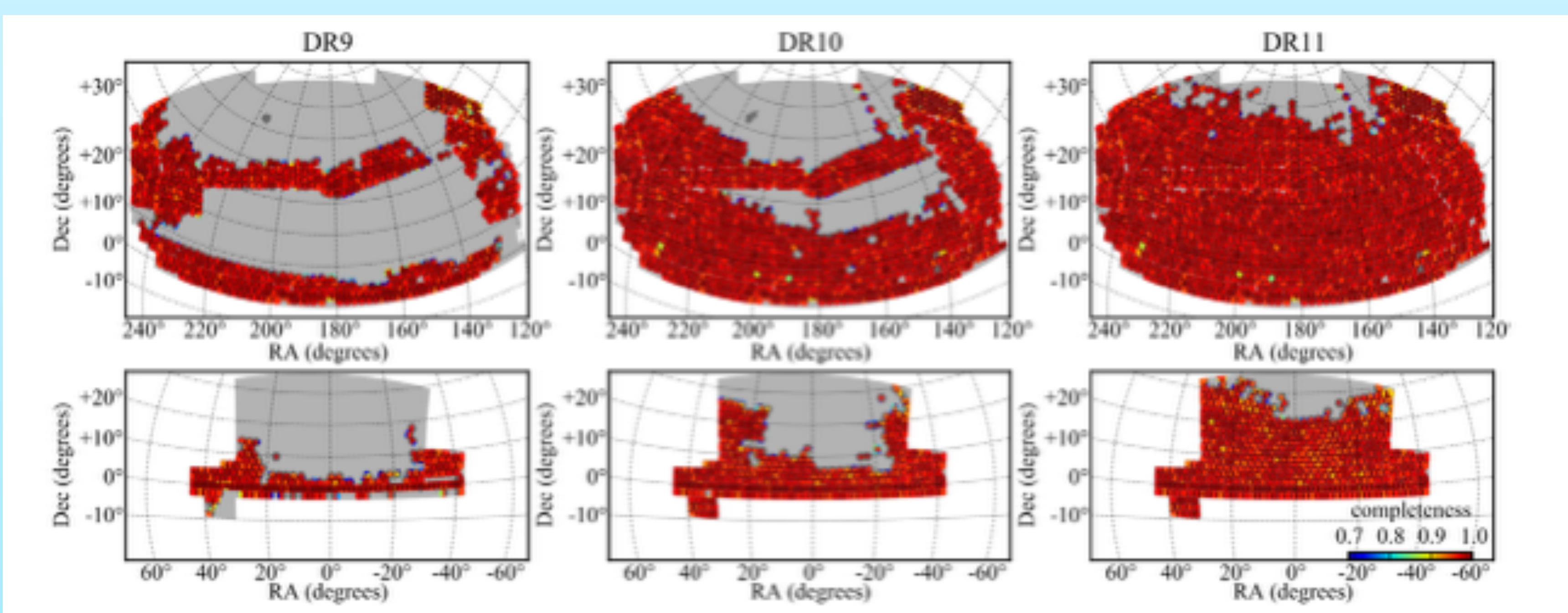
BOSS at a glance
(Baryon Oscillation Spectroscopic Survey)

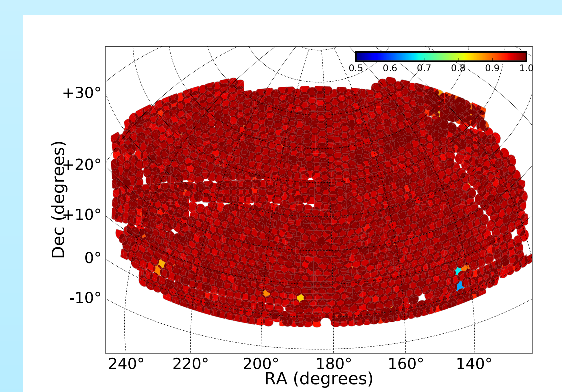
- Uses 2.5 m SDSS telescope, APO
- Will get spectra of

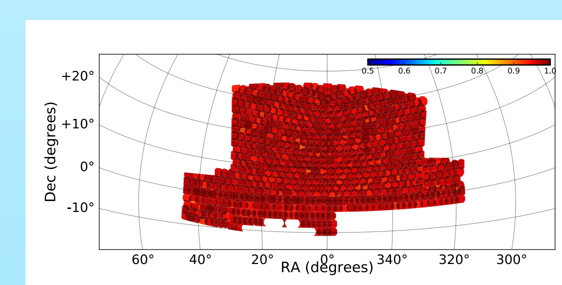
    1.5M LRG (z<0.7)

    160,000 QSOs (2.2<z<3)
- Sky Area: 10,000 sq. degrees
- Wavelength: 360 nm (UV),1000 nm (IR)
- Medium resolution: R~2000
- Survey completed June 2014



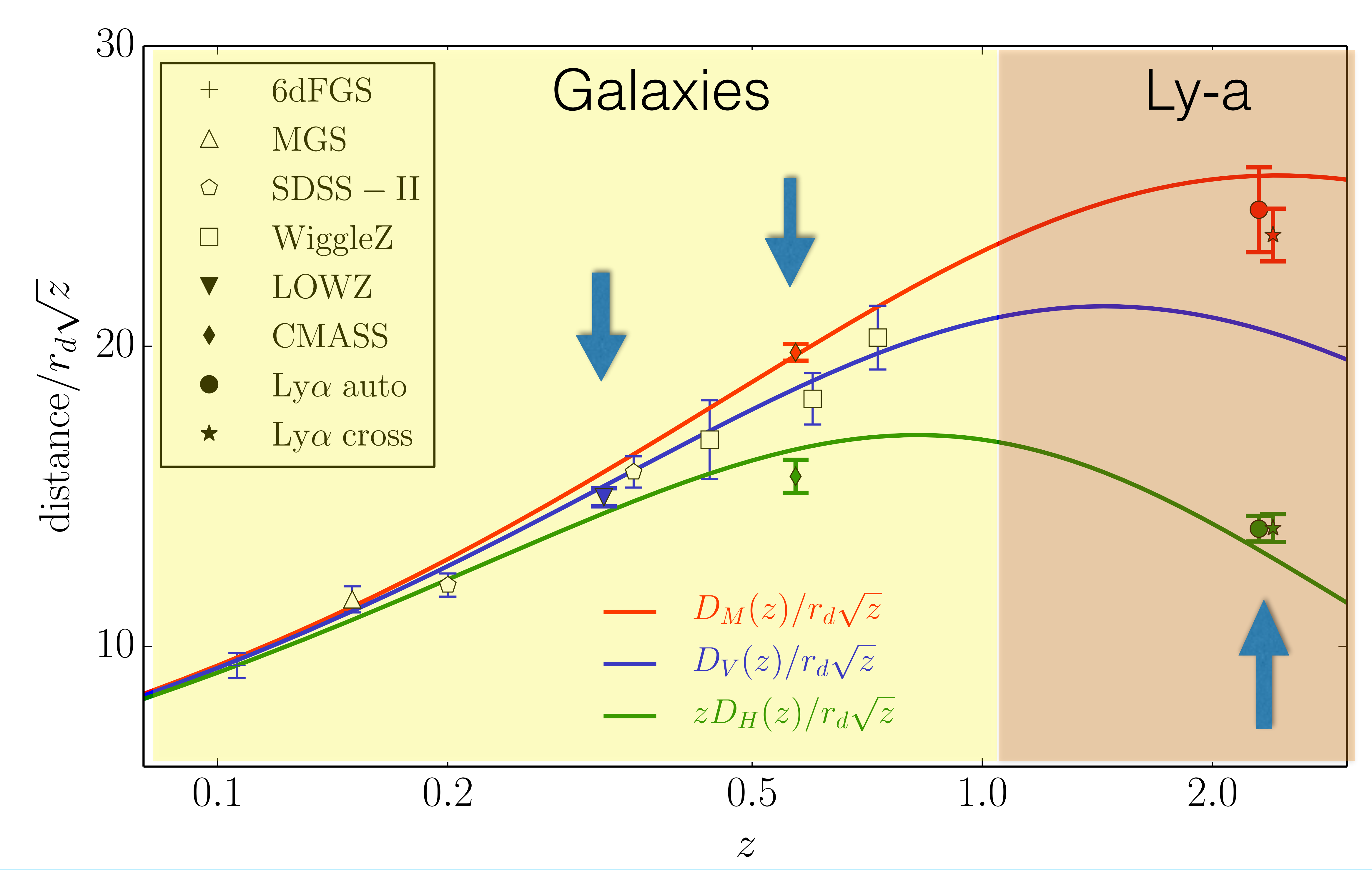






BAO data

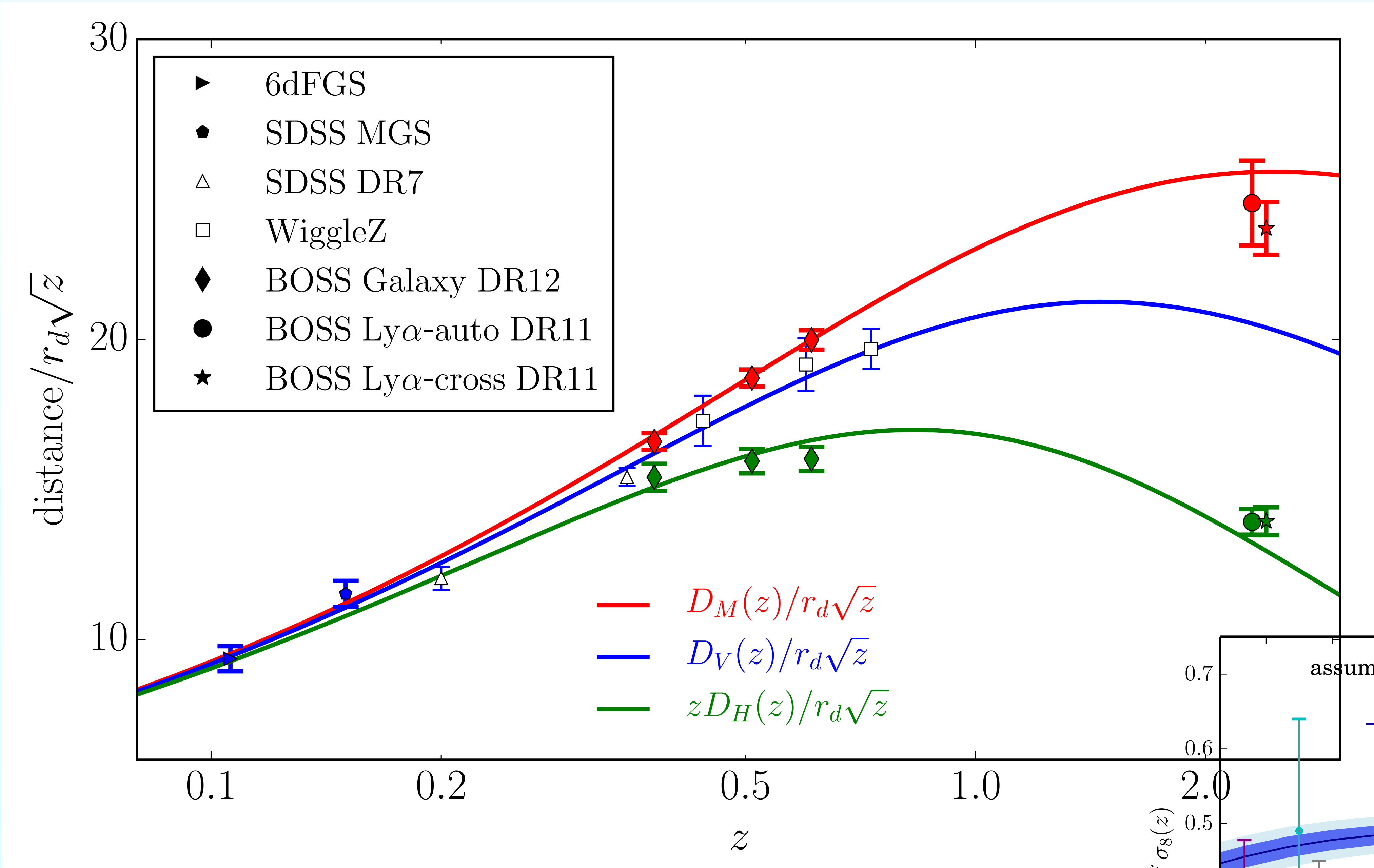
The BAO "Hubble diagram" from a world collection of detections.

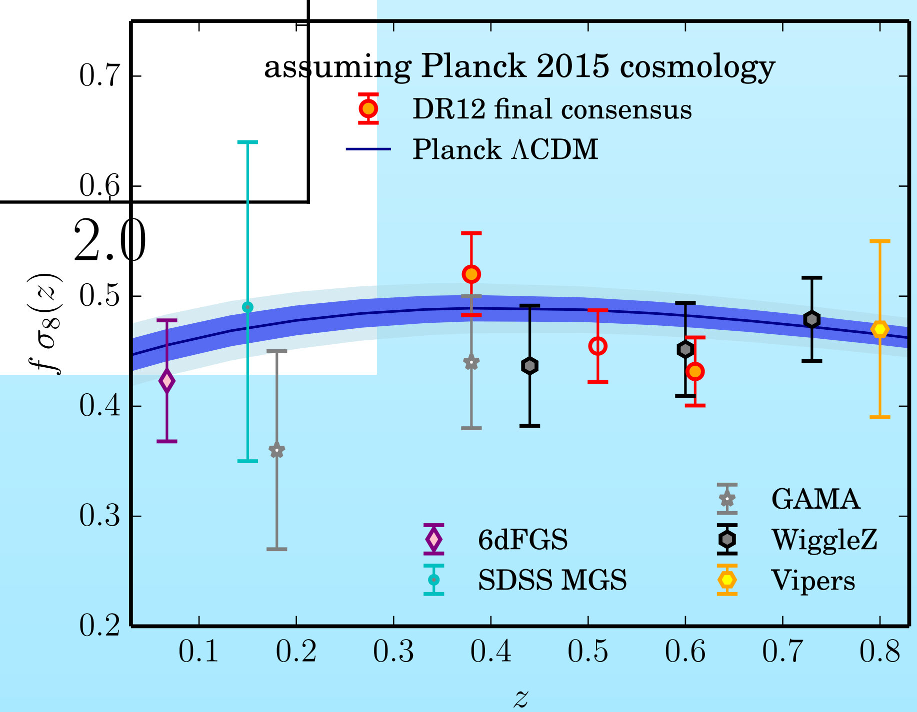


Lines are Planck best fit predictions

new

The BAO "Hubble diagram" from a world collection of detections.





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EMBARGO DATE: 2016 July 14, Thursday 09:00 EDT.

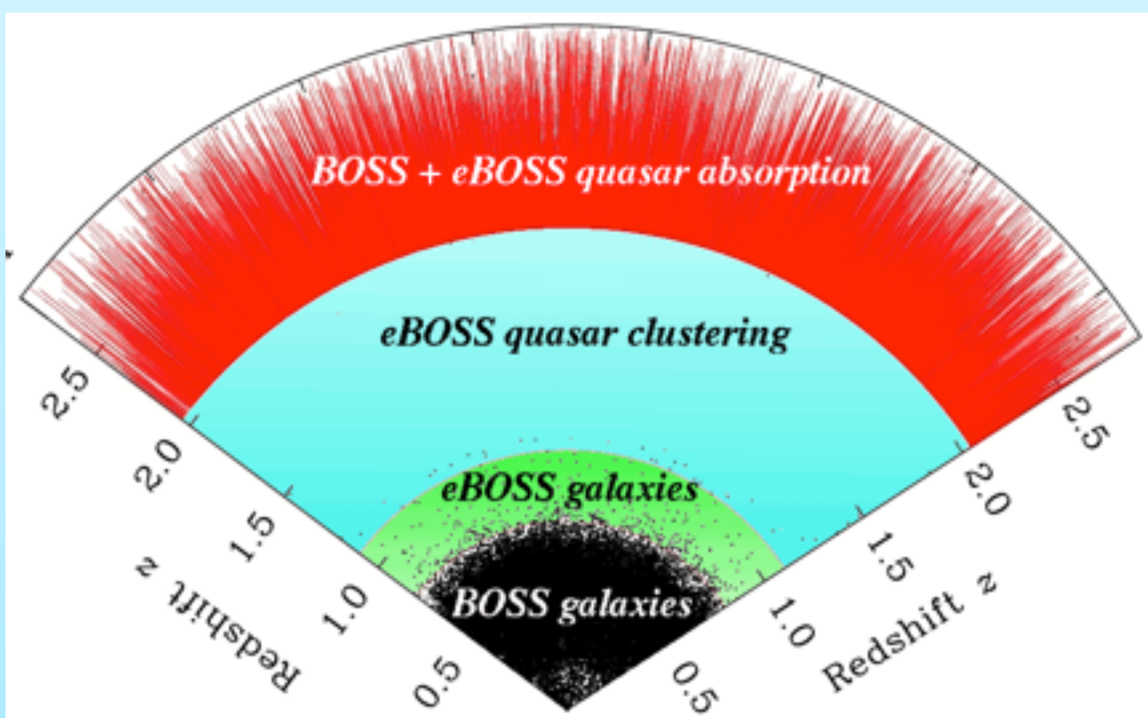
ASTRONOMERS MAP A RECORD-BREAKING 1.2 MILLION GALAXIES TO STUDY THE SECRETS OF DARK ENERGY

Astronomers announced this week the sharpest results yet on the properties of dark energy. Hundreds of scientists from the Sloan Digital Sky Survey III (SDSS-III) collaborated to make the largest-ever, three-dimensional map of distant galaxies. The scientists then used this map to make one of the most precise measurements yet of the dark energy currently driving the accelerated expansion of the Universe.

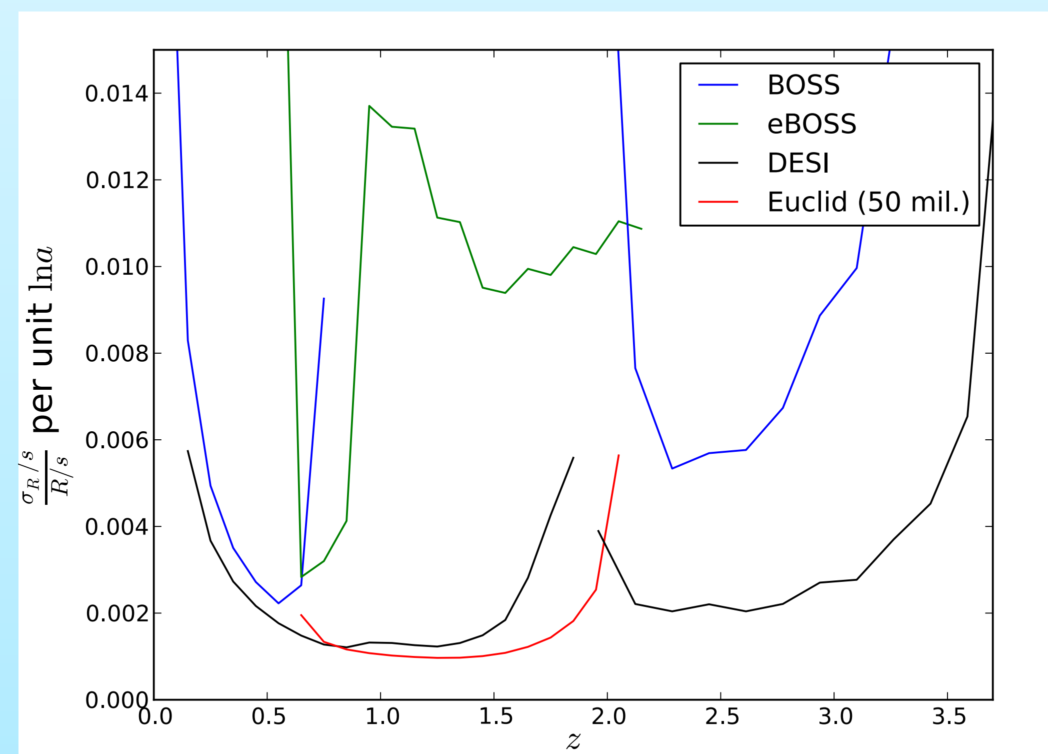
The Future

Table 1: Summary of current or planned BAO capable spectroscopic surveys. [Eisenstein, 2001][Hogg, 2005] [Drinkwater, 2010][Scrimgeour, 2012] [Eisenstein, 2011][Bolton, 2012] [Hill, 2008] [Abdalla, 2012] [Schlegel, 2011] [Ellis, 2012] [de Jong, 2012] [Amiaux, 2012]

Instrument	Telescope	Nights/ year	No. Galaxies	sq deg	Ops Start
SDSS I+II	APO 2.5m	dedicated	85K LRG	7600	2000
Wiggle-Z	AAT 3.9m	60	239K	1000	2007
BOSS	APO 2.5m	dedicated	1.4M LRG+160K Ly-α	10000	2009
HETDEX	HET 9.2m	60	1M	420	2014
eBOSS	APO 2.5m	180	600K LRG + 70K Ly-α	7000	2014
DESI	NOAO 4m	dedicated	+20M + 800k Ly-α	14000	2018
SUMIRE PFS	Subaru 8.2m	20	4M	1400	2018
4MOST	VISTA 4.1m	shared facility	6-20M bright objects	15000	2019
EUCLID	1.2m space	dedicated	52M	14700	2021



fractional error on the BAO distance scale



arXiv:1308.0847v1